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| Title: | <i>Standard operating procedure for the performance of Transcutaneous CO₂ measurement</i> |
| Area: | Acute Respiratory Unit, RSCH |
| Date: | 23/03/23 |
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| Purpose of the SOP: | To standardised the procedure for the performance of Transcutaneous CO ₂ monitoring. |
| Scope: | To be used as part of the titration of home NIV set-up at the Royal Sussex County Hospital, University Sussex Hospitals NHS Foundation Trust. Staff involved: Home NIV service staff, ward nurses and respiratory consultants. |
| Knowledge base: research recommendations | <ol style="list-style-type: none"> 1. TcCO₂ has been shown to have good correlation values with PaCO₂, however, it is recommended that arterial/capillary blood gas values are compared to transcutaneous readings to verify values. This should be done periodically and as dictated by patient's condition. 2. Physiological limitations of TCM: <ul style="list-style-type: none"> • Profound peripheral vasoconstriction • Compromised peripheral circulation • Circulatory centralization (shock) • Arterial occlusive diseases • Arteriovenous shunts (such as persistent ductus arteriosus) • Increased thickness or oedema of the skin and/or subcutaneous tissue where the sensor is applied • Hypothermia • Use of vasoactive drugs 3. It is recommended that sites used for a TCM be changed as often as necessary and that they be alternated and observed to avoid thermal injury. For adults, the TCM5 sensor can stay on one site for a maximum of 12 hours. When changing the sites, the new fixation ring/earclip should stay as close to the original site as possible to avoid differences in readings. |
| Indications for TcCO₂ analysis: | <p>Patients who are being set up with home non-invasive ventilation who:</p> <ol style="list-style-type: none"> 1. Are in-patients and will require overnight continuous monitoring of oxygen and carbon dioxide with minimal blood draws. 2. Patients who need overnight titration and who lack arterial access. |

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| <p>Equipment:</p> | <ol style="list-style-type: none"> 1. Transcutaneous CO₂ monitor: current model TCM5 Basic Radiometer. 2. TCM5 BASIC (including a sensor 92) 3. Multi-patient consumables: <ul style="list-style-type: none"> • Sensor membrane (for the sensor 92) • Calibration gas. • Electrolyte fluid (when re-membrating the sensor only) 4. Single-patient consumables: Ear attachment, Fixation rings 5. Contact gel (for patient fixation only) 6. Gauze or paper towel, distilled water fluid (when re-membrating the sensor only) 7. 70% ethanol solution to clean the sensor cable |
| <p>Preparing the equipment: placing a membrane on the sensor for first time use or if membrane needs changing.</p> | <p>Note: This process does not need to be repeated every time the device is used.</p> <p>The sensor needs to be remembrated once every 28 days, or if used extensively or if the sensor does not pass three consecutive calibrations:</p> <ol style="list-style-type: none"> 1. Switch on the monitor 2. Menu > Overview > Start re-membrating 3. Tap the start button 4. Follow the instructions on the screen and tap the next button on the screen 5. Remove the sensor from the calibration chamber on the left side of the monitor. 6. Use the V-shaped notch of the preparation supply to remove the membrane retainer ring. 7. Use a lint-free cloth soaked in distilled water to remove the used membrane and to clean the sensor surface. 8. Dry the sensor surface until the 100% limit on the screen is reached. 9. Open the membrane retainer ring and apply two drops of the preparation supply electrolyte fluid (blue label bottle). 10. Place the sensor surface pointing downwards into the preparation supply and press gently until it is locked. 11. Closed the preparation supply and press until you hear the retainer ring click into position. 12. Remove the sensor and clean remaining electrolyte fluid from the surface. 13. Put the sensor in the calibration chamber and press calibrate on the device. |
| <p>Patient testing:</p> | <p>Note: Avoid placement of the sensor in areas of increased thickness or oedema of the skin and/or subcutaneous tissue (see physiological limitations above).</p> <ol style="list-style-type: none"> 1. Explain the procedure to the patient, making sure that they understand why the test is needed. Describe the steps involved and that they will feel heat from the sensor. 2. Switch the monitor on. 3. Make sure that the sensor is placed in the sensor calibration chamber before the TCM5 is switched on (this will allow for the sensor to be calibrated each time the device restarted). |

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| | <ol style="list-style-type: none"> 4. Make sure that the sensor has passed the calibration process. 5. The sensor 92 temperature (for adult testing) should be maintained at 42°C. Once set, the TCM5 will remember the temperature setting. Sensor temperature is permanently shown on the front screen on the left hand side. 6. Make sure units are set at kPa, which should be the default unit of measure. 7. If the monitor is used to measure SpO₂ as well, the sensor should only be placed on the patient's earlobe or forehead. 8. The TCM5 will produce a record in CSV format if needed. 9. Clean the area where the sensor is going to be placed. 10. Take an ear clip or a fixation ring and place it on the area to be used for monitoring. If using an ear clip, firmly press the ear clip to ensure good seal once in place. If using a fixation ring firmly run your finger around the ring to ensure good seal. 11. Apply two drops of the contact gel (grey label bottle) in the centre of the ear clip or fixation ring. 12. Remove the sensor from the sensor chamber and place it on the ear clip or fixation ring with membrane facing downwards. Gently push until you hear a click and it is well attached. Maintain a bit of slack on the cable using the clothes clip. 13. Await to get results. 14. The sensor will begin to warm up, which should take 10 minutes. 15. Wait until the TcCO₂ comes up in blue colour to record results. 16. Make sure that site of the sensor is changed as often as necessary and that they be alternated and observed to avoid thermal injury. <p>Once monitoring is no longer required, remove the sensor from the attachment. Clean it with a gauze or paper towel and 70% alcohol solution and place in the sensor chamber. Remove the attachment from the patient and wipe the area for any excess fluid. Dispose in the clinical waste bin.</p> |
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Further reading:

1. American Association for Respiratory Care Guidance on TcCO₂ monitoring:
Restrepo, R.; Hirst, K.; Wittnebel, L., and Wettstein, R. 2012. *AARC Clinical Practice Guideline: Transcutaneous Monitoring of carbon Dioxide and Oxygen: 2012*. Respiratory care . Vol 57 (11), pp: 1955-1962
2. Storre, J. H. et al. Transcutaneous monitoring as a replacement for arterial PCO₂ monitoring during nocturnal non-invasive ventilation. *Respiratory Medicine* 2011; 105, 1 (2011): 143-150.